Tropical storm-induced near-inertial internal waves during the Cirene experiment: energy fluxes and impact on vertical mixing

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Near-inertial Internal Waves (NIW) excited by storms and cyclones play an essential role in driving turbulent mixing in the thermocline and interior ocean. Storm-induced mixing may be climatically relevant in regions like the thermocline ridge in the southwestern Indian Ocean, where a shallow thermocline and strong high frequency wind activity enhance the impact of internal gravity wave-induced mixing on sea surface temperature. The Cirene research cruise in early 2007 collected ship-borne and mooring vertical profiles in this region under the effect of a developing tropical cyclone. In this paper, we characterize the NIW field and the impact of these waves on turbulent mixing in the upper ocean. NIW packets were identified down to 1000 m, the maximum depth of the measurements. We estimated a NIW vertical energy flux of up to 2.5 mW m-2 within the pycnocline, which represents about 10% of the maximum local wind power input. A non-negligible fraction of the wind power input is hence potentially available for subsurface mixing. The impact of mixing by internal waves on the upper ocean heat budget was estimated from a fine-scale mixing parameterization. During the first leg of the cruise (characterized by little NIW activity), the average heating rate due to mixing was ~0.06°C month-1 in the thermocline (23-24 kg m-3 isopycnals). During the second leg, characterized by strong NIW energy in the thermocline and below, this heating rate increased to 0.42°C month-1, indicative of increased shear instability along near inertial wave energy pathways.

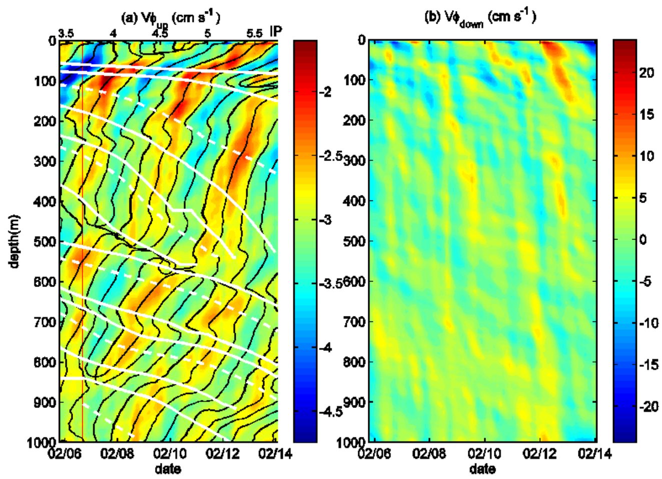

Figure 1: Fixed point station LADCP meridional velocity component during leg 2 separated in upward (left) and downward phase propagation, black lines represent line of constant phase obtained after complex demodulation of rotary current, whites lines represent rays trajectories computed form the vertical group velocity. The time axis below the left panel indicates the dates, while the time axis above the panel indicates the number of inertial periods after the first eyewall passage (e.g. after the 24th of January 2007).

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